



ASSESSMENT TASK

The water front bench

Subject: Y10 Extended
Mathematics

Topic: Polynomials

Name Jonathan Poon
(Class): Y10(T)

Reading material: Chapter 2 & 6 in Book A

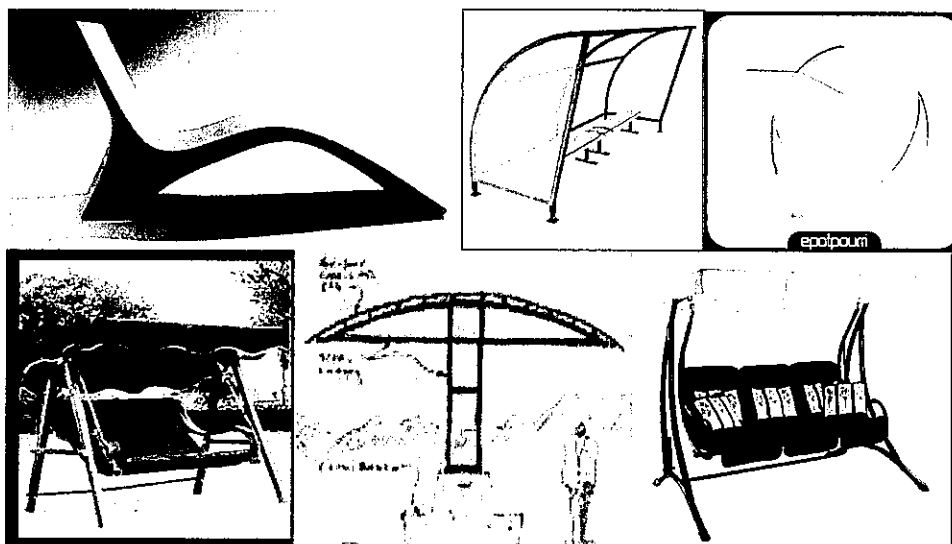
Date of task assigned: 22nd September, 2011

Due Date: 6th October, 2011

Submission of task: Please submit a print copy of the assessment to your Maths teacher on or before Thursday, 6th October 2011 at 0840.

This task assesses Criteria A, C, & D.

Task Brief: Design a water front bench with a canopy.



ADVICE:

Read the criteria descriptors and task-specific rubrics carefully before you start your work. This will give you a clear understanding of what is required and what a high quality piece of work for this task must include.

This way you give yourself the best chance of achieving the highest levels in this task.

Please attach these sheets to your final report.

The Task

Background

You have been hired as a new designer at the *Polynomial Seating Company (PSC)*. The company is world famous for designing and manufacturing creative and attractive seats and benches, mainly for outdoor use. The Manager is giving you a special task for a new client.

You are given the task of designing a chair/bench for use outdoors. The client wants your designs quite quickly. So does the manufacturing department of PSC, as they will want to start production quite soon.

The bench should be (a) comfortable, (b) suitable for keeping off the sun and the rain and (c) have a profile that is highly mathematical in shape – in fact it should use functions that you have met in this topic of Polynomials (i.e. quadratics and cubics).

Of course, you won't **build** the bench, but you will come up with the functions (equations) that will define the shape of the bench.

You will submit a report that outlines the development of your design. The report will be assessed using MYP Assessment Criteria A, C and D, and the paragraphs below expand on this.

Criterion A:

Here you show your **knowledge and understanding** of quadratic and cubic equations and their graphs. You **MUST** provide all the appropriate information about your design specification including:

- Accurate plots of all graphs, showing the important features of the design;
- Sets of equations describing all curves used and listing the range of x-values;
- The process (mathematics) by which you came up with the equations used in the design including possible modifications that could be made if requested by the client.

In order to score top marks in this criterion, you should show how you have used your knowledge in **unfamiliar situations** by embedding and developing at least one function that has not been covered in class, such as trigonometric, exponential, logarithmic etc.

Criterion C:

Your design needs to be **communicated** effectively for your manager, the client, and the manufacturing department who will use it to make the actual bench. This means that all graphs will be clearly labeled, and all appropriate diagrams and charts will be explained. Equations will have to connect sensibly to appropriate units of distance.

Any software used will have to be cited and, if necessary, explained.

Criterion D:

Before you begin your design, it is important that you come up with a set of specifications so the client can see how comfortable, sheltered, and creative your design will be. You need to **reflect** (and possibly research) on associated real-life issues, such as:

- People's sizes and comfort levels;
- How people sit or lounge;
- How the sun and the rain act;
- How easily the bench might be stored away;
- Any other features that you believe may be relevant to the product.

Once you have finished your design, please **evaluate** it against the specifications you listed before you began. Consider how well your model fits your specifications by checking the degree of accuracy (possibly percentage error or sig. fig.). Because the client wants the initial design in just a few days, there may well be a number of things you cannot do. If you had more time, suggest what other things you might do to improve your product? What different mathematical methods might you have tried?

Assessment Criteria for Y10 Extended Maths Bench Assessment

Criterion A		
Levels	Task-Specific Rubric	Official IB Descriptors
0	The student does not reach a standard described by any of the descriptors given below.	
1-2	The student generally makes appropriate selections of one or more simple functions (such as $y=mx+b$, $y=x^2$) and manipulates them in to form a chair/bench.	The student generally makes appropriate deductions when solving simple problems in familiar contexts.
3-4	The student generally makes appropriate selections of two or more non-linear functions (eg quadratics or cubics) and manipulates them to form a chair/bench with a canopy.	The student generally makes appropriate deductions when solving more complex problems in familiar contexts.
5-6	The student generally makes appropriate and accurate selections of three or more sophisticated functions (eg higher order polynomials, trigonometric functions) and manipulates them to form a chair/bench with a canopy.	The student generally makes appropriate deductions when solving challenging problems in a variety of familiar contexts.
7-8	The student consistently makes appropriate and accurate selections of four or more sophisticated (eg higher order polynomials or trig) functions and at least one unfamiliar one (eg circles, roots, exponentials, logs, hyperbolas etc) to form a chair/bench with a canopy.	The student consistently makes appropriate deductions when solving challenging problems in a variety of contexts including unfamiliar situations.

Criterion C		
Levels	Task-Specific Rubric	Official IB Descriptors
0	The student does not reach a standard described by any of the descriptors given below.	
1-2	Some very basic equations are offered and described. There are some appropriate diagrams and graphs. There is a basic narrative that describes the processes used.	The student shows basic use of mathematical language and/or forms of mathematical representation. The lines of reasoning are difficult to follow .
3-4	Equations used are generally clearly explained. Clear, accurate and relevant graphs, and/or charts and tables are provided. It is generally easy to see how these diagrams describe the development of the chair/bench design. Key vocabulary is used. Narrative is generally accurate.	The student shows sufficient use of mathematical language and forms of mathematical representation. The lines of reasoning are clear though not always logical or complete . The student moves between different forms of representation with some success .
5-6	Several graphs and diagrams are offered to show the development of the chair/bench. Graphs are accurate and detailed. Equations are provided which match the important features of the graphs. It would be possible for PSC engineers to produce the chair/bench from the diagrams. The narrative is very clear.	The student shows good use of mathematical language and forms of mathematical representation. The lines of reasoning are concise, logical and complete . The student moves effectively between different forms of representation.

Criterion D		
Levels	Task-Specific Rubric	Official IB Descriptors
0	The student does not reach a standard described by any of the descriptors given below.	
1-2	There has been a limited amount of relevant research undertaken. To some degree, the student has connected this research to the design of the chair/bench.	The student attempts to explain whether his/her results make sense in the context of the problem. The student attempts to describe the importance of his or her findings in connection to real life where appropriate.
3-4	The student has undertaken good, relevant research and has used this in the development of the chair/bench. The student has explained with justification how the design features of the chair/bench relate to real-life issues. The student tries to explain the accuracy of the equations.	The student correctly but briefly explains whether his/her results make sense in the context of the problem. The student describes the importance of his/her findings in connection to real life where appropriate. The student attempts to justify the degree of accuracy of his/her results where appropriate.
5-6	The student critically compares the final product with features identified at the design stage. Real-life issues associated with the design are developed. The student justifies appropriateness and accuracy of all equations and offers a critical review of the mathematical methods used, suggesting viable alternatives or improvements where appropriate.	The student critically explains whether his or her results make sense in the context of the problem. The student provides a detailed explanation of the importance of his/her findings in connection to real life where appropriate. The student justifies the degree of accuracy of his/her results where appropriate. The student suggests improvements to his/her method when necessary.

Bench Research

Bench is a kind of furniture, which can allow several people to sit on it at the same time. Benches are mainly made of wood, but may also be made of metal, stone, or other kind of materials such as plastics. Many benches have arm and back rests, some of them have no back rest and can be sat on from either side. Nowadays in public park, there are even benches that have cover on the top for shading from sun and rain. Also it has improved to at most 4 people can sit on a bench. In public areas, benches are often donated by associations or sponser by the government. By making the bench more comfortable there are usally cushion on the bench for indoor design mainly.

Bench is quite a part of our life, and without a bench, you can't rest when you are tired. You don't have and place for rest, or even working spaces. In the bench research, I have found some measurements of bench height, width (all units in cm). Most of the lower part of the bench is around 40-50cm tall from the ground and the total height of the bench is around 100cm tall and around 150-200cm long. In nowadays, designer colored their bench in beautiful colors and extreme unique design which get many people's attention. They have used mix color, they even design a little table beside the bench for working use, so the idea of design of bench is keep improcing and developing. After research I have done on the bench, it help me a lot and I think I might have a good progress throughout this project with less problems and difficulties.



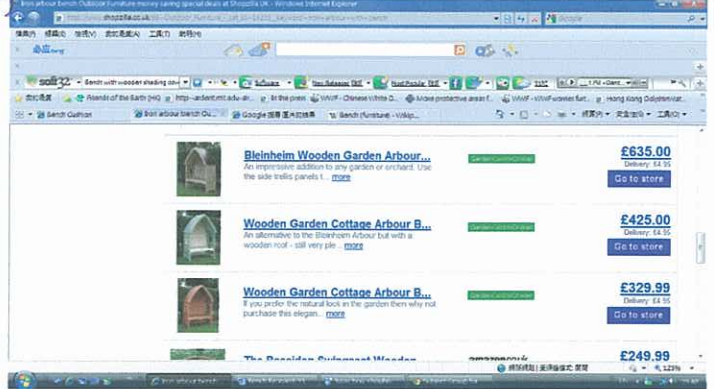
Caption: From google image research

Images of Benches

1.) Bench in indoor with Cushion:



2.) Benches with Canopy:



3.) Benches with three handles:



4.) Benches with no Handles:



5.) Bench with handles on the side



6.) Bench with no handles



7.) Bench with special design



David Stine's Wave Bench is made of sustainably harvested Black Walnut from his family farm in Illinois.

Footnote: All Image 1.) -7.) all are come from the google image research.



By asking and recording several classmates' back length, upper leg and lower as to design the best bench:

Student 1: Back:51cm, Upper leg:47cm, Lower leg:48cm

Student 2: Back:52cm, Upper leg:49cm, Lower leg:55.5cm

Student 3: Back:53cm, Upper leg:50cm, Lower leg:55cm

Student 4: Back:54cm, Upper leg:54cm, Lower leg:53cm

Student 5: Back:48cm, Upper leg:50cm, Lower leg:52cm

Student 6: Back:49cm, Upper leg:52cm, Lower leg:50cm

Student 7: Back:48cm, Upper leg:50cm, Lower leg:50cm

Student 8: Back:49cm, Upper leg:50cm, Lower leg:50cm

Student 9: Back:49cm, Upper leg:52cm, Lower leg:54cm

Student 10: Back:46cm, Upper leg:54cm, Lower leg:52cm

Student 11: Back:47cm, Upper leg:50cm, Lower leg:51cm

Student 12: Back:50cm, Upper leg:54cm, Lower leg:53cm

Student 13: Back:55cm, Upper leg:54cm, Lower leg:52cm

Student 14: Back:44cm, Upper leg:46cm, Lower leg:47cm

Student 15: Back:46cm, Upper leg:47cm, Lower leg:49cm

Student 16: Back:43cm, Upper leg:45cm, Lower leg:46cm

Student 17: Back:47cm, Upper leg:46cm, Lower leg:49cm

Conclusion of my data:

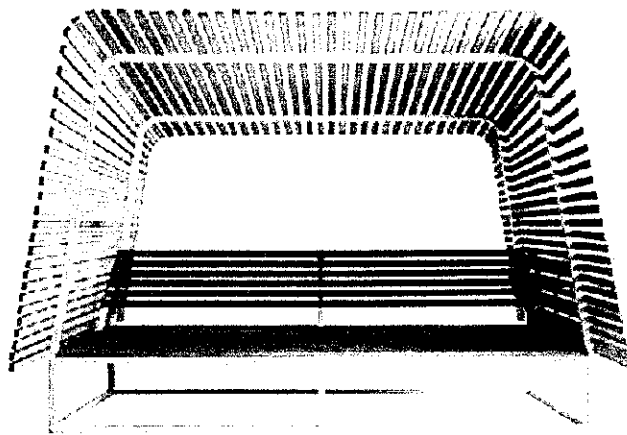
The above data show that the measurements of my classmates, my family members of their upper legs long, lower legs long and also their back length as to design a suitable bench for them to sit on for a rest or other use. After measurements my classmates and some of my relatives, I discover that the average height of the people is around 168cm tall. Their back, upper legs and lower legs are not too long, which make me more easier to design the bench as to fit their size. I choose to make my bench sit around 40-50cm and the lower leg 40-45cm tall from the ground.



Specification

Essential Criteria:

For my bench design, I am going to use Geogebra, calculator as the main resources for designing my bench and also Internet for my research. The image below is where my idea came from to design my bench. It is a bench with canopy mainly for covering sunshine and rain, because the bench is designed to put in a park for public use, so it is basic needs. After the data collection from my measurement of my classmates' back, lower and upper legs length, I decided to make the bench around 2.5m tall, the sit is around 0.4-0.5m(40-50cm) long and the lower leg around (40-45cm) tall from the ground. I have used the data well to design a suitable bench to sit on. My bench will use quadratic equation, linear equation, circles, roots and cubic mainly, I will also use transformation in one of my equation.



Footnote: This image is came from the Google image research column

Desirable Criteria:

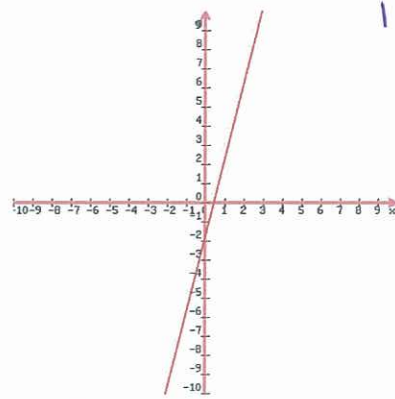
For desirable criteria, I will try to use logs or other kinds of unfamiliar equations if I have enough time to do it. I will use some colors and points to present more clear and easy to understand for my bench design. Also, if I have enough time, I will try to use a circle as one of the bench support underneath, it would be quite a fashionable design.

Body part of my Bench Design

For my bench design, I am going to use different equation to form a bench, here is all of my equations and transformers with graph explanations. I have used the technique such as quadratic equation, linear equation, functions, circles, roots and cubic equation, segment mainly, I will also use transformation in one of my equation

Equation1: Linear Equation

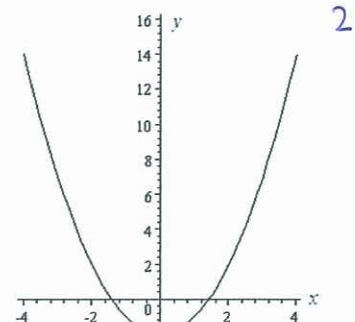
I firstly used linear equation as my side support of my bench design. As you can see beside, it is the linear equation show in a graph. Linear equation is more easier than the others, I type in $x=1.2$, then I keep changing the point by adding or minus as to fit the top cover of the bench. Then I used segment to cut the line. After I put two points B and G to clear out the line and put a co-ordinate on it. Afterwards, it was the same step to repeat as to make the other side of the side bench support, I name point F and H.



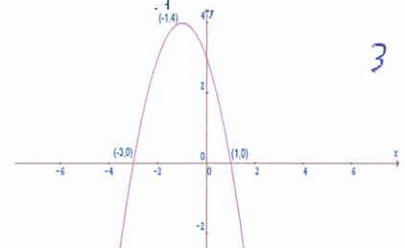
Equation 2: Quadratic Equation

$$y=x^2, f(x)=-(5)/3(x+0.02)^2+7/5(x+0.23)+2$$

As you can see in the graph, it is shown that $y=x^2$ in a graph line, it is the very first step. This quadratic equation is the top of my bench, which is used for covering sunshine and rain, is make up of this equation. I transformed it, I firstly use



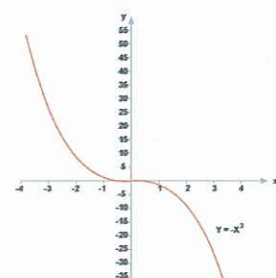
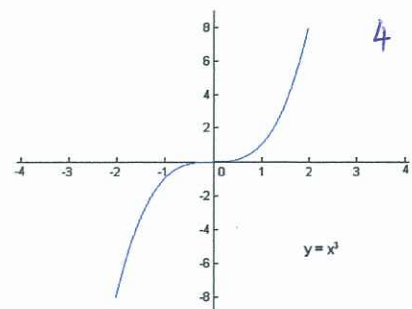
a negative sign to turn the shape upside down, like the underneath image. In the equation, $-(5)/3(x+0.02)^2$ and $7/5(x+0.23)$ is to move the increase or decrease the width of my curve line. Finally the equation $+2$ is to change the height of the line.



Equation 3: Cubic Equation

$$-(3.8)x^3+3.6x^2+0.5$$

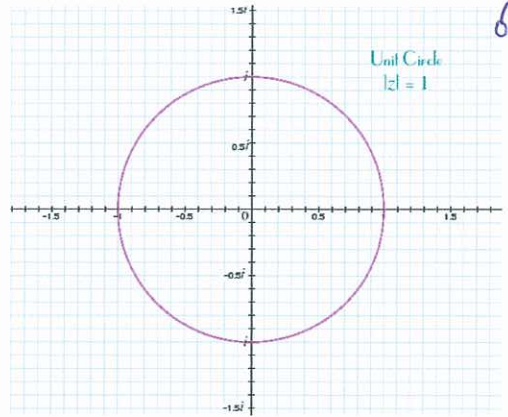
Thirdly, I am going to use Cubic equation to form my main part, which is the sit of the bench design. The basic equation is $y=x^3$. Firstly, I change the equation $y=x^3$ to $y=-x^3$ which is turn it to the other side like the image underneath. I change the length of the sit and the length of the foot stand by using the cubic equation ax^3+bx^2+cx+d , keeping changing the numbers to try if one of them fits my specifications. I have used a red color for painting this line.



Equation 4: Circle

$$(x-0.1)^2 + (y-0.2)^2 = 0.05$$

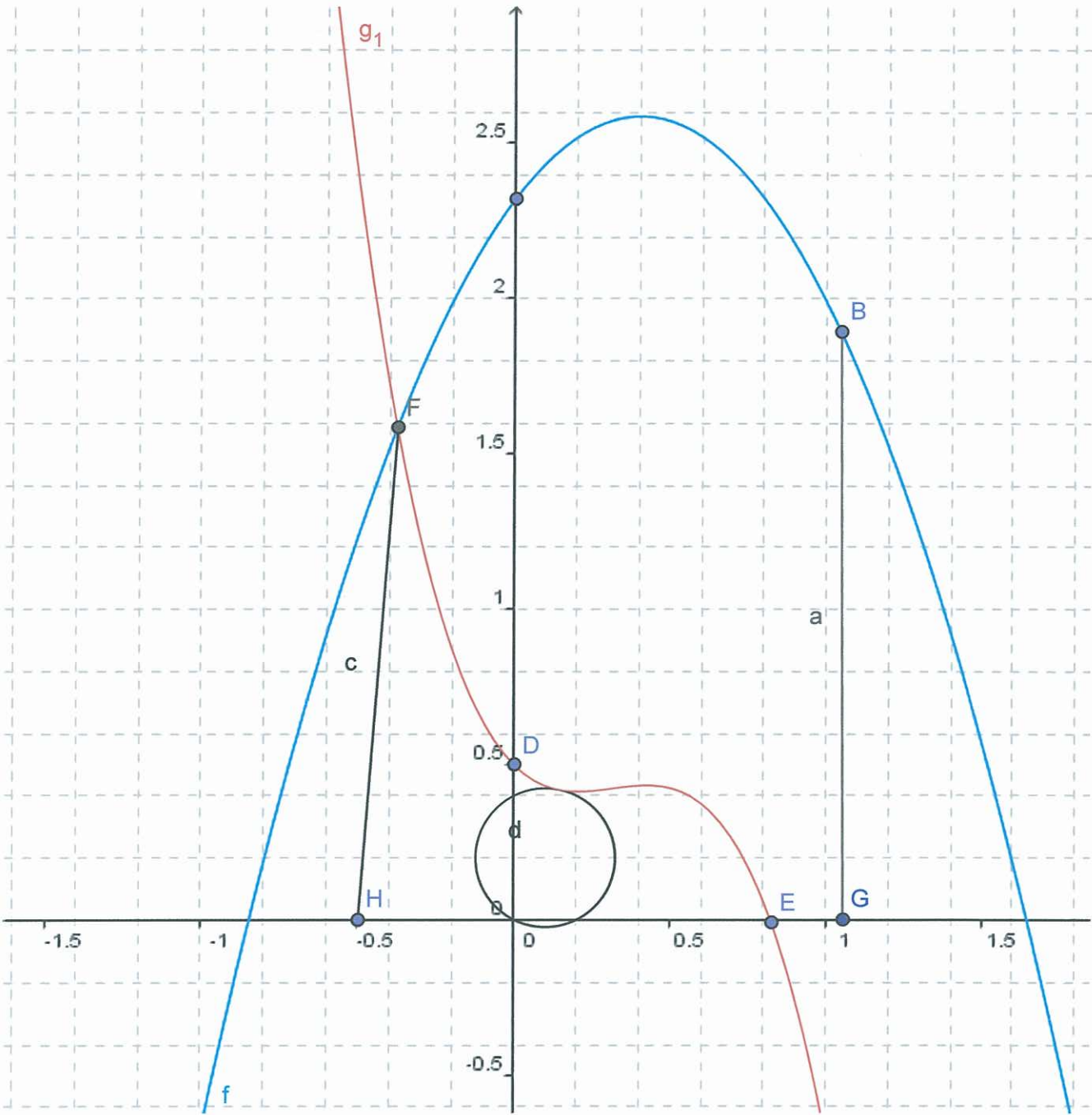
Lastly, I use an unfamiliar equation that is circle as a support of my bench. After the research stage that I have been through, I discovered that there were many benches/chairs use circle as one of the support because of fashion. Afterwards, I designed in my own bench. Firstly, I use the equation of $x^2 + y^2 = 0.05$. Then I use $(x - 0.1)^2$ to change the x-values which was to move it right or left by changing the positive or negative sign. On the other side, $(y - 0.2)^2$ is to change the y-values by + or - and also the height.



Footnote: This image is came from the google image research.

Calculations and Graph of Water Front Bench (side view)

Jonathan Poon Y10 Trust



Bibliography

"Bench in Anapa, Russia." *Wikipedia, the Free Encyclopedia*. Web. 25 Sept. 2011.
<http://en.wikipedia.org/wiki/File:Bench_in_Anapa,_Russia.jpg>.

"Bench Cushion." *Instructables - Make, How To, and DIY*. Web. 25 Sept. 2011.
<<http://www.instructables.com/id/Bench-Cushion/>>

Shop Bench Canada. Clothes for Women, Men, Girls and Boys. Web. 25 Sept. 2011.
<<http://www.bench.ca/>>

"Bench." *ChestofBooks.com: Read Books Online for Free*. Web. 25 Sept. 2011.
<<http://chestofbooks.com/home-improvement/woodworking/Cabinet-Making/Bench.html>>.

"Make a 5-Board Bench with Charles Neil [FS] | Free EBooks Download - EBOOKEE!" *Ebookee: Free Download EBooks Search Engine!* Web. 25 Sept. 2011.
<http://ebookee.org/Make-a-5-Board-Bench-with-Charles-Neil-FS-_1319269.html>

Kromminga, Cyndee. "How to Make a Bench Cover | EHow.com." *EHow | How to Videos, Articles & More - Trusted Advice for the Curious Life | EHow.com*. Web. 25 Sept. 2011. http://www.ehow.com/how_4827765_bench-cover.html

"Great Workbench and Woodworking Books." *Workbench Design Home Page*. Web. 25 Sept. 2011. <<http://www.workbenchdesign.net/rbooks.html>>

Free Woodworking Plans at Bink's Wood Working. Web. 25 Sept. 2011.
<<http://www.binkyswoodworking.com/>>

Park Bench - Outdoor Bench - Wood Park Benches Information - ParkBenches.info. Web. 29 Sept. 2011.
<<http://www.parkbenches.info/>>

"Commercial Bench Information | Park Bench Source." *Commercial Park Benches, Logo Park Benches, Teak Benches, Aluminum Benches, Steel Benches | Park Bench Source*. Web. 29 Sept. 2011.
<<http://www.parkbenchsource.com/commercial-bench-info>>

